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ABSTRACT

This paper reports on a pilot study in the Danish "Profile in Mathematics" project implemented by the Directorate General for Employment, Placement and Vocational Training and the Ministry of Education. The pilot study develops and tests specific guidance materials to guide participants and teachers through a course for crane workers that teaches the workers to choose the right tools and fit them correctly on the load that is to be lifted or moved. The guidance materials consist of two packages: the first aims at disclosing the participants' skills; the second aims at providing more profound insight into the participant's skills. After testing the researchers found new discrepancies between school mathematics and workplace mathematics, especially concerning decimetres and methods of estimating the area of figures. Testing also showed that the participant's thoughts were consistently on the possible consequences of their involvement in the pilot project. (ASK)

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Developing Guidance Material to uncover a Mathematics Profile of Adult Participants on a Crane Course

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The focus of this conference session was a pilot study in the Danish "Profile in Mathematics" project implemented by the Directorate General for Employment, Placement and Vocational Training and the Ministry of Education. The project was introduced at ICME 8, 1996 by Tine Wedege:

> Wedege (1997:152) described that the original working title of the project "Diagnostic Test in Mathematics" had to be changed because each of the words "diagnostic", "test", and "mathematics" is enough to make many adults shudder. As the purpose of the project was not to test and sort, but rather to create a basis for advising the individual participant with a point of departure in his/her mathematical skills, the title has now been changed to "Profile in Mathematics". The point at issue in the project is, on the one hand, the difficulties experienced by early school leavers with regard to requirements concerning their arithmetic and mathematical skills in adult education programmes. On the other hand, it is the teachers' lack of opportunity to differentiate the teaching in relation to the qualifications and needs of the individual participant.

The pilot study develops and tests specific guidance material. When this material is fully developed it will be used to guide participants and teachers on a course for crane workers which teaches them to choose the right tools (wires and hawsers) and to fix them correctly on the load which is to be lifted or moved. Later on material will be developed adjusted to the different types of courses for each trade.

The course takes place within the framework of the Adult Vocational Training System in Denmark. It is, therefore, regulated by the Ministry of Labour, not the Ministry of Education. Most of the participants are adults who were early school leavers; most of the teachers are former skilled workers. It is a full-time three week course which focuses on personal safety, the correct use of lifting equipment and efficient processing of goods. Mathematics is not the focus of the course but is mostly integrated with other areas (eg with the concept of Working Load Limit), except for the measurement of area and cubic measure, which are taught separately.

Aims of the guidance material

It is our aim that the material should uncover the participants' math-containing skills and life experience from everyday and work relevant to the specific course. The material is to uncover both what the participant can do and knows and what he/she lacks. It should also suggest how the participant can set out on a conscious and relevant learning process.

The material can be used at the start of a course, not as an entrance examination but for individual screening of a participant's difficulties and potential for handling the particular course. It can also be used during the ongoing course to provide background information on

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specific difficulties experienced by the individual participant and to provide information about the potential for overcoming these difficulties.

The guidance material consists of two packages

The material that has been developed consists of two packages:

- The first package aims at disclosing the participant's skills which indicate the areas he/she might succeed in or might experience difficulties in during the course. The first package consists of an individual paper and pencil test. The items are organised in numeracy components; each item has only one right answer.
- The second package aims at providing more profound insight into the participant's skills, conceptions, methods and potential for learning concerning those numeracy components in which the participant did not succeed in the first package. The second package consists of a dialogue with a specialist teacher about issues organised in the same numeracy components. Concrete materials and photos are used as part of this dialogue. Participants who have not experienced any difficulties with first package will not be offered the second package.

Six Phases in the Pilot Study

The pilot study for constructing and testing the two packages in the material for this course consists of six phases.

First phase:

By analysing the written textbooks in use, we formulate no more than ten central numeracy components.

Second phase:

Constructing the first package of about twenty paper and pencil test items. Constructing the second package of questions and materials for dialogue. Constructing forms for documentating and evaluating the individual participant's difficulties and potential.

Third phase:

Testing the first and the second packages at three institutions with 45 participants answering the first package and 12 dialogues on the second package. The testing was carried out by two senior students of mathematics.

Fourth phase:

Analysis of results of testing the first and second packages.

Fifth phase:

Considerations of the possible background of the participants' revealed difficulties: are they based on context, lack of other skills, blocking, resistance, or special forms of understanding? Considerations of how to make more invisible potential visible.

Sixth phase:

Revision of the first and second packages.

The first, second and third phases have been completed. At present the study is in phase four analysing the testing results.

Working Model for Numeracy

In this project numeracy is seen as being composed of four dimensions. The first dimension comprises the kind of material one observes and reacts to. We call this the dimension 'genre', the second dimension is 'skills', the third is different possible contexts, and the fourth is different personal aims.

Genre	Skills	Context	Personal aims
raw quantitative data	roughly estimating	at home	to get qualitative or quantitative information
prose:texts from newspapers, magazines, brochures and manuals	geometrical sense	at the actual workplace eg in the trade building	to construct
document: tables, schedules, charts, graphs, maps and forms	numerical sense	at workplaces from the past or the future, perhaps in another trade	to fill out
concrete materials without figures and text	sense of weight	shopping	to control
oral information	knowledge of number manipulation	as a citizen	to examine and to assess
	modelling competencies	as a pupil in the school	to grasp
		as an adult learner at the current vocational training course	to qualify for further training
		as an adult learner at future training courses	to be entertained
		in the world of mathematics	to be confirmed or get one's arguments sharpened
		in the test situation	

Figure 1: Working Model of Numeracy

The working model can be helpful in structuring different kinds of analytical and pragmatic work on numeracy.

Numeracy components in the course for crane workers

In this pilot study we first used the working model as a tool for analysing the textbook in use in the course. That extracted eight areas of handling cranes which involved numeracy components. The eight areas were the following:

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1. If the weight is stated on the material to be moved, one should know what gross weight, net weight and tare stand for. If the weight of the material is not stated, one should calculate or estimate it. That involves calculating or estimating volume, which might be complicated. If one does not know the specific gravity, one must locate it in a table. Then one has to multiply by using corresponding units on volume and specific gravity.
2. In order to keep security distance, one should physically know what half a metre is. One should be able to read and understand stated lengths, area and volume.
3. In order to fix the hawser properly on a long girder, one should calculate or estimate fractions of the length of the girder
4. Under some special conditions (heat, the hook, the wire is twisted around the material), the Working Load Limit is reduced. One has to calculate or estimate eg reduction *of* 30%, a reduction *of* 50% or a reduction *to* 80%, and a reduction *to* 40%.
5. Estimating whether the spreading angle between two wires is of the ideal 60 degrees, or 90 or 120 degrees.
6. When one uses two wires the actual maximum loading is dependent on the spreading angle between them. One has to estimate whether it is less than 30 degrees, between 30 and 90, or between 90 and 120. To find the actual Working Load Limit, one has to either multiply the WLL figure by 2, multiply it by 4 and divide by 3, or keep it as it is.
7. There is not yet any international agreement of standards for which angles are stated on the cranes. So one has to be able to convert between the two kinds in use.
8. It is laid down by law that the crane worker must check the different tools. There are specific limits for scrapping. One has to measure by slide gauge, calculate 5%, 10% and 1/3, and assess the figures. The check must be documented.

From these eight areas of handling cranes, we extracted eight central numeracy components:

fractions
percentages
measure of lenght
measure of area
geometrical figures
angles
cubic measurement, including specific gravity
conversions

Then we constructed the first package and the second package. Firstly, we constructed for each of the eight components a number of items for the paper and pencil test in the first package. Secondly, we constructed for each of the eight components a number of questions and materials for the dialoque in the second package.

Preliminary analysis of the test results

Testing was conducted by two mathematics students who were in the final phase of their studies. It started by letting 45 participants attending the courses at three different adult vocational training centres answer the first package. Then 12 of the 45 participants were chosen to engage in dialogues on certain numeracy components of the second package - those components in which the participant did not succeed in the first package. The dialogues were not taped but documented and analysed on three separate forms. The dialogue was conducted by one of the mathematics students while the other took notes on a form concerning

occupation, skills and conceptions. After the dialogue the two mathematics students together filled out two forms. One form was on the contexts that the participant seemed to prefer. The second form dealt with the participant's interests, confidence and engagement in telling about his/her conceptions and experience with numeracy.

The analysis of the testing is still ongoing, so only some preliminary results can be stated at present. It seems that the organizing principle of having two packages has proved functional. Some minor corrections of the individual paper and pencil test items seem to be appropriate, eg on fractions and percentages. It seems that more concrete materials available at the adult vocational training centres school should be incorporated in the second package.

Our testing has revealed new discrepancies between school mathematics and workplace mathematics, especially concerning decimetres and methods of estimating the area of figures, and we have become more aware of how the choice of terms indicates the context. We also need to be more careful about the layout and choice of font (the letter l should not be mistaken for the number 1).

Although the two forms for documentating the dialogues seem to be easy to use and to allow some insight into the participant's potential, self-confidence and interests, we are still looking for more ways of how to uncover even more.

How to create conditions for the material being used to empower the participants

The testing showed that the participants' thoughts were consistently on the possible consequences of their involvement in the pilot project: would it entail consequences for the ongoing course? Could it be 'used against me'? Some participants felt uncomfortable about engaging in the first package even though they were told it was a test of the material, not of themselves, and even though they were allowed to put their own secret mark on the front page.

This shows, that when the fully developed material is to be used on a larger scale, we have to be very careful about how to present the aim of the material and how to organise its use. We intend to produce a video explaining the intentions of the material to the participants which should ensure that all participants get the same information. It is also our intention to make the documentation and evaluation of the results of the first and second packages available and understandable to the individual participant. Taking the second package is each participant's choice and if he chooses not to, he can still participate in the further program. Lastly, it is our intention to ensure that there are specially trained teachers to implement the second package and that they have materials at their disposal for participants wanting to develop the skills they lack.

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